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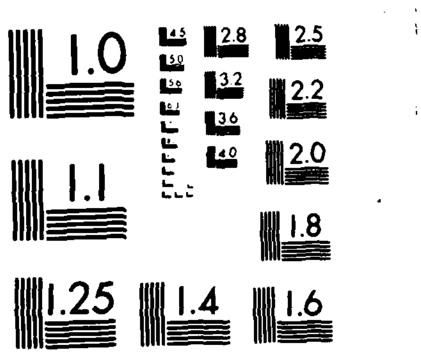

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FINAL TECHNICAL REPORT

CONTRACT NO. DAAH01-80-C-0349

MICROCIRCUIT PACKAGE SEALING AND LEAK TESTING

April 29, 1981

Prepared for:
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DRSMI-ET
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1. INTRODUCTION

1.1 Background; Objectives

The U.S. Army Missile Command, DRSMI-ET, Redstone Arsenal, Alabama, (hereinafter referred to as MICOM) produced a high-throughput unified system for sealing and leak-testing microcircuit metallic packages. This system was custom-designed and built under the technical direction of MICOM by the collaboration of a number of contractor companies, as an MM&T task. The ultimate objective of the task was to advance the capability of the DoD/Industry team in the area of high-volume production of high-reliability cost-effective hermetically-sealed metallic-packaged hybrid microcircuit modules, by the development and demonstration of this unified sealing and leak-testing system. Contract No. DAAH01-80-C-0349 was awarded by MICOM to Huntsville Microcircuits, Inc. (hereinafter referred to as HMI) with the objective that HMI procure sample metallic packages for use in the development and demonstration of the MICOM sealing/leak-testing system, and provide engineering labor support for the evaluation, demonstration, and documentation of that system. The specific requirements delineated in the Scope of Work, page 10 of the subject Contract, defined the framework for this effort.

1.2 Activities Performed

994 Uniwall packages, Tekform Products Co. P/N 35000, 8-pin, nickel-plated to 100 microinches, and 1000 stepped lids, Tekform Products Co. P/N 35009, nickel-plated to 100 microinches, were procured by HMI and delivered to MICOM. (The initial lot of packages received by HMI had been found unacceptable by MICOM due to excessive roughness of the sealing surfaces; upon their return to Tekform Products Co., the latter determined that a manufacturing step had inadvertently been left out. Tekform reworked these packages and returned them, in acceptable condition, to HMI.) HMI made two attempts to check out the Package Feed-through Leak

Tester fabricated by PDC Associates, but both times, leaks too great to allow Tester operation were detected in the Tester, and the latter was returned to PDC for repair. Delays in the completion of the main sealing system prevented HMI access to that system until the latter part of March 1981. At that time, HMI, working in collaboration with MICOM personnel, performed the system check-out, performance evaluation, and documentation. HMI prepared the overall system operating procedure included as Section 2.4 of this report, and assisted MICOM in the preparation of the pictorial and videotape documentation of system design, operating procedure, and performance capabilities. HMI performed the performance evaluation, yield study, and throughput rate analysis which are documented in Section 3 of this report.

2. DOCUMENTATION OF MICOM PACKAGE SEALING SYSTEM

2.1 System Description

2.1.1 Package Feed-through Leak Tester

This machine consists essentially of: a spring-loaded clamping fixture for pressing 30 packages, inverted, simultaneously against a sealing gasket, with the package cavities thereby being connected via solenoid valves to a manifold; an O-ring-sealed cover assembly which forms a pressurizable chamber over the packages and clamps; status indicators and controls. By operation of the controls, the package cavities are evacuated and the chamber above the packages is evacuated and back-filled with helium. Then the valved manifold connects all the packages, in parallel, to a Veeco helium mass spectrometer fine leak detector. If leakage is detected, then the sequencer is actuated and the valves connect sequentially each package cavity, one at a time, to the helium mass spectrometer, until the leaking package(s) is isolated. The Package Feed-through Leak Tester is intended for receiving-inspection of packages, to ensure that modules are not bonded into defective packages.

2.1.2 Package Sealing and Leak-testing System

See Figure 1 for an overall view of the system, with the major subsystems labelled. Noteworthy features of the system are: The combining of the functions of vacuum bake, seam sealing, gross leak testing, and fine leak testing, for essentially two independent production lines, all in one controlled-atmosphere enclosure; as required to accomplish this, the use of dry pressure/volumetric gross-leak detection, and the use of a 10% helium atmosphere in the front end of the system during seam-sealing. The system is designed to operate at a manufacturing throughput rate of 100 modules per hour. The major subsystems are as follows: dual vacuum bake-out ovens for removing trapped contaminants; dual SSEC parallel overlapping-spot resistance seam-welders; dual gross-leak testers operating on the principle of fixed volumetric compression of a small chamber containing the test package, with chamber pressure change indicating package leak-in; fine-leak tester consisting of 28 simultaneously-sealable test-chambers connected to a sequencer-controlled solenoid-valved manifold connected to a Varian mass spectrometer helium leak detector. The seam-welders and gross leak testers are enclosed in a SSEC glovebox purged with a flow of dry 90% nitrogen 10% helium; the vacuum bake-out ovens are back-filled with this same mixture, which serves thereby as the detecting medium for the fine leak detector, eliminating the need for helium "bombing". A DuPont Moisture Monitor measures the dew point of this sealing atmosphere. The fine leak tester is housed in a nitrogen-purged glovebox. Photohelic units indicate the pressures inside these gloveboxes and provide fast-filling flows of nitrogen in the event of rapid arm-withdrawals; bubblers control the normal operating pressures, with special fast-vent bubblers limiting the maximum pressure in the event of rapid arm-insertions. A partially-evacuable nitrogen-flushing transfer lock is provided between the sealing glovebox and the fine-leak-testing glovebox, to minimize helium background and package surface adsorption spurious leak indications.

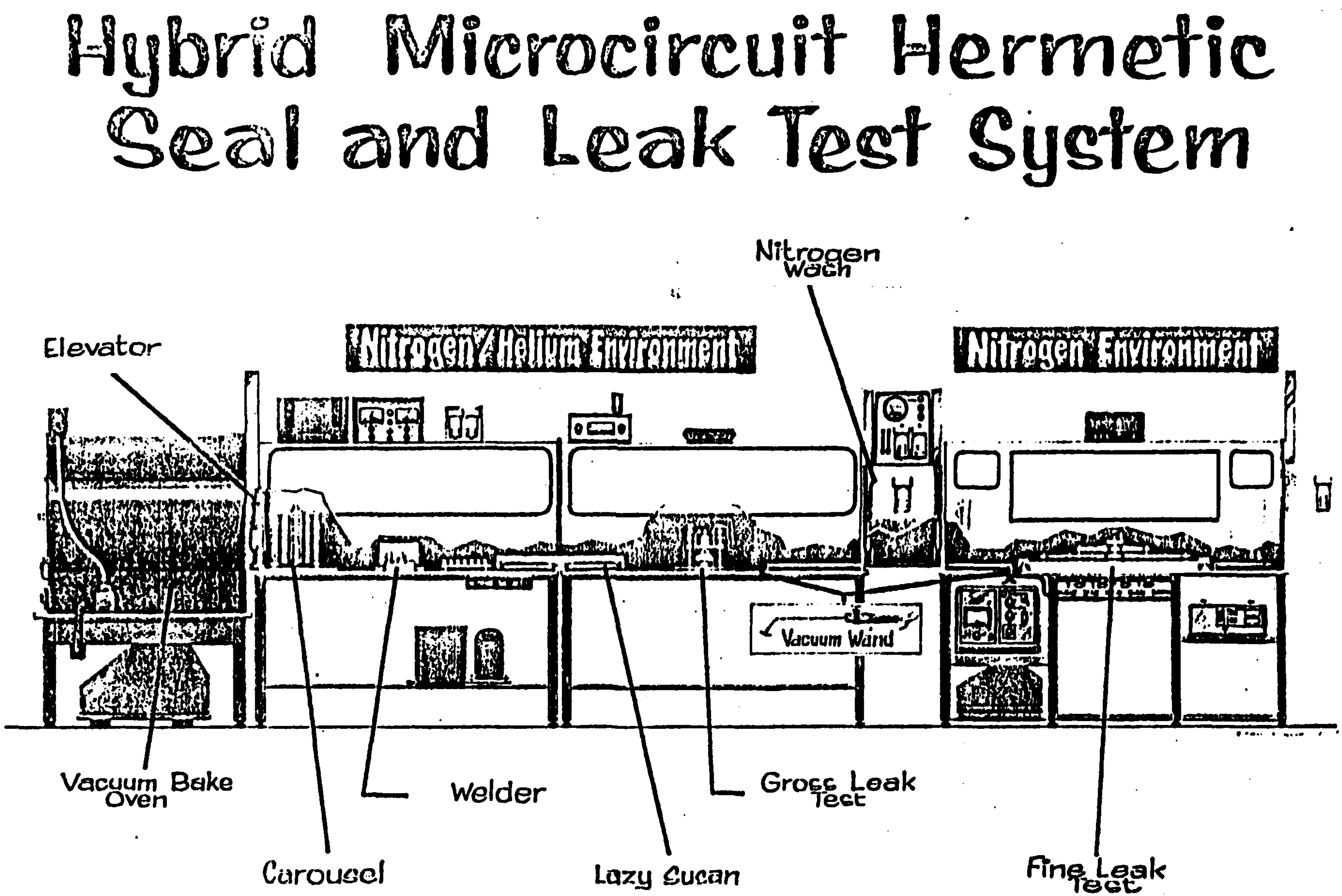

Figure 1. Overall View of System

Let us now examine the features of this system from another perspective, by following the flow of operations as a typical microcircuit module is processed through the system.

The first step is the loading of the modules onto locating-studs on the 16 shelves of the carousel-type vacuum-bake magazine. Each shelf holds 26 modules, and contains a wide notch that allows access to the other shelves when rotated. The loaded magazine is placed in the vacuum oven for vacuum bake and back-fill with 90% nitrogen 10% helium. Refrigerated cold-traps prevent back-streaming of pump oil vapor into the vacuum ovens. Each of the two ovens is capable of holding three vacuum-bake magazines. After bake and back-fill, the pneumatically-operated door between the oven and the sealer glovebox is opened, the movable oven shelf is rolled out, and the magazine of modules is slid over onto the elevator, which then lowers it to the floor of the glovebox. The packages are now placed, one at a time, into the recess in the seam-sealer work-table, the lids are placed (if not already placed before vacuum bake), centered, and clamped by the spring-loaded clamping finger. The welder is actuated, and parallel seam welds are made, as the work-table rolls forward under the electrodes, turns 90^{o} in azimuth, then rolls back to the loading position. The sealed modules as they are removed from the sealer work-table are placed on a Lazy Susan, which carries them to the gross-leak test station, as well as providing intermediate storage. The modules are then placed, one at a time, into the cavity of the gross-leak tester, using a vacuum parts-handler. To reduce operator hazard from the pneumatic tester mechanism, the operator must place both hands on the control box to actuate the tester. An outer cylinder comes down around the module, forming an O-ring-sealed chamber. Then an inner piston comes down, compressing the entrapped gas. A sensitive pressure transducer detects changes in chamber pressure as minute quantities of gas leak into a faulty package. The transducer signal goes to a threshold detector with level adjustable to compensate for varying package size and pressure decrease as the heat of adiabatic compression leaves the entrapped gas. The threshold detector drives go/no-go indicator lights. The adjustable cycle time before the test chamber automatically opens furnishes a means of trading off leak-detection sensitivity

vs. production throughput rate. The tested modules, accumulated on stackable stainless steel trays, are now moved into the nitrogen-wash inter-glovebox transfer lock, and the inlet door is closed. The functions of this lock are to isolate the fine leak tester from the helium-bearing atmosphere of the sealing section and to remove adsorbed or superficially-entrapped helium from the package surfaces and weld porosities. The modules are subjected repetitively to several cycles of partial vacuum and pure nitrogen back-fill. Then the stack of module trays is moved into the fine leak tester glovebox and the lock outlet door is closed. The fine leak tester contains 28 O-ring-sealed test-chambers, which (with modification per Paragraph 4.2.13) allow 28 modules to be fine-leak-tested either simultaneously in parallel (if yields are at a high level) or individually in sequence. Each test chamber is connected by its own solenoid valve to a manifold, which in turn is connected to a Varian mass spectrometer helium leak detector. The sealed modules are loaded, one into each of the 28 test-chambers, using a vacuum parts-handler. Then the pneumatically-operated cover-assembly is brought over the test-chambers, and the individually-spring-loaded covers are caused to make an O-ring seal with each chamber. After rough-pumping, the automatic sequencer opens the valve to each chamber, serially, thereby exposing each module to the helium mass spectrometer. The sequencer contains a threshold level detector which looks at the output signal of the mass spectrometer; when a leaky package is detected, a red failure light comes on, in the numbered indicator light matrix on the sequencer display panel. The level of mass spectrometer output which will trigger a failure indication can be varied by a potentiometer in the sequencer, to allow selection of the go/no-go threshold leak rate. After the sequencer has completed its leak-test cycle, the test-chambers are vented, and the cover-assembly is raised and moved back, by actuation of its air-cylinders. The modules are then removed from the test-chambers and placed on stacking trays. The inner door of the outlet gas-lock is opened, the stack of trays is placed inside, the inner door is closed, the outer door is opened, and the finished, tested modules are removed.

2.2 Drawings; Manuals

A set of engineering drawings for the custom-designed components, and a set of manufacturer's manuals for the standard components, are available through MICOM.

2.3 Pictorial; Videotape

Still photographs of the system, showing mechanical details of the major components, were made by MICOM, with the assistance of HMI.
A narrated videotape "movie" was made by MICOM, with the assistance of HMI, showing system configuration, operating procedure, and performance capabilities.
This documentation is available through MICOM.

2.4 System Operating Procedure

2.4.1 Package Feed-through Leak Tester

Connect tester to Veeco helium mass spectrometer fine leak detector, house vacuum line, 5 psig helium supply, and 115 VAC power. Place 30 packages, cavity side down, over the 30 holes in the rubber sealing gasket of the tester. Bring the clamp assembly down into position over the packages, and tighten, to exert spring pressure on the bottom of each package. Close the upper chamber cover over the packages, and tighten the cover latches. By operation of the solenoid valve switches on the tester control panel, open the valves between the package cavities and the manifold, open the upper-chamber valve, and open the low-vacuum valve. When vacuum gauge stops moving, close upper-chamber valve and low-vacuum valve, and open helium valve, thereby back-filling upper chamber with helium. When vacuum gauge indicates atmospheric pressure in upper chamber, close helium valve, and open the high-vacuum valve, thereby exposing simultaneously all package cavities, via the manifold, to the Veeco helium leak detector. Set up, calibrate, and operate the

latter according to the Veeco detector manual, to measure helium leak rate. If no leakage above 10^{-8} cc/sec is detected, all packages are acceptable. If greater leakage is detected, close the valves between the package cavities and the manifold, then, by repeated pressing of the sequence-advance switch, open each individual package valve in turn, thereby sequentially connecting each package cavity to the Veeco leak detector. Watch the display meter of the latter, and match any failure indication (say a leak rate greater than 10^{-8} cc/sec) to the package concurrently being exposed to the Veeco leak detector, as indicated by the numbered indicator lamps on the tester control panel. After test completion, close high-vacuum valve, unlatch and raise upper-chamber cover, release spring-clamp assembly, and remove packages. (If vacuum seal lubricant is used on the rubber gasket, this must be cleaned from the packages after testing.)

2.4.2 Main System Start-up Procedure

General:
Turn on electric power, 60 psi air supply, 30 psi dry nitrogen supply, and cooling water supply.
Vacuum Bake-out Ovens:
See that inner and outer doors are fully closed (as shown by door indicator lights being off). Set temperature controller to 125°C and over-temperature limiter to 135°C. Turn on heater switch, push reset button on over-temperature limiter, turn on cold-trap refrigerator switch, turn on vacuum pump switch and vacuum gauge switch.
Gloveboxes:
Turn on power switches on the two Photohelic units; set the low pressure limits to 0.5" water and the fast-fill cut-off limits to 1" water, on the Photohelic units. Set valved inlet flowmeter of sealing glovebox to 100 scfh; set valved inlet flowmeter of fine-leak-test glovebox to 60 scfh; set outlet transfer lock valved flowmeter to 15 scfh. Turn on 15 psi helium supply, and set ratio of helium flow to nitrogen flow, as indicated by the two supply flowmeters, to 1:9, by adjusting the flowmeter valves. Note: the helium supply flowmeter needs to be calibrated for helium; its face values are quite inaccurate when used with a

low-density gas.
Note: to conserve helium, turn on helium one hour before beginning sealing, and turn it off as soon as sealing is completed, allowing the nitrogen flow to keep the system purged during inactive intervals.
Seam Welders:
Turn on power switches, on both upper and lower control panels. Set Solenoid 1 switch to 2, set Solenoid 2 switch to "off" (for square packages; for rectangular packages, set Solenoid 2 switch to 1 or 2), set Table Feed Rate to 30, set Input Amps to 700, set Pulse Width to 40, set Pulse Repetition Time to 40, set Resistance Level to midway in the red band, and set Weld Delay to minimum. Loosen the lock-nuts and set the screw-adjustments so as to position the roller electrodes laterally and vertically so as to give smooth rise and centered passage of the electrodes over the package-to-lid interface or weld-line when the "weld" switch is pushed. Clean the electrodes with fine sandpaper if oxidized or pitted. Set the "weld" Microswitch to come on (as indicated by the green "weld" light coming on) the instant the package leading edge passes the weld-electrode centerline, and to go off the instant the package trailing edge passes the same point. Note: proper settings for a particular package design and situation must be determined by trial and error; the values given here may serve as a starting point.
Gross Leak Testers:
Turn on 24VDC power supply, and turn on power switch on tester control box.
Fine Leak Tester:
Insert standard calibrated leak into inlet port of Varian mass spectrometer, tighten seal nut, close vent valve, open V1 and V2, turn on Varian unit electronics switch. After pressure indication drops into the green band, turn diffusion pump pointer to "warm-up". After about 20 minutes, press filament switch, and turn diffusion pump pointer to mid-range sensitivity. After a few minutes, calibrate the leak detector read-out meter vs. the standard leak, "tuning" the detector if necessary, according to the Varian detector manual. Set the sequencer go/no-go lamp threshold adjustment potentiometer (behind the sequencer front

panel) to indicate failure at a leak rate of about 10^{-7} cc/sec of helium, when sequencer power switch is on. This should correspond to an output signal of about 30 mVDC from the Varian leak detector; for setting the threshold, the Varian detector output signal level can be varied by moving the meter zero adjustment knob on the Varian control panel. Then close V2 and open vent valve, loosen nut and remove the standard leak, and connect in place of the latter the flexible tube from the fine-leak-tester glovebox, into the Varian leak detector inlet, tightening the seal nut. Close vent valve. Varian diffusion pump and spectrometer tube must never be exposed to atmospheric pressure when operating.

2.4.3 Package Sealing and Leak-testing Procedure

Vacuum Baking:
Remove rotary module-magazine from oven. Load modules onto the 16 shelves of the magazine, over the positioning studs, rotating the shelves as necessary for access. Handle modules with tweezers or lint-free gloves. Place lids on packages (this step may be deferred until after vacuum bake). Put magazine in oven, close outer door, turn on vacuum switch; pressure should drop below 100 microns. Allow to vacuum-bake for 1 to 24 hours, as desired. At completion of bake, turn vacuum switch to "vent" (back-fill is controlled by right-hand flowmeter valve on sealing-glovebox control panel, which is connected to the 90% nitrogen 10% helium supply line). When oven pressure reaches atmospheric as indicated by dial vacuum gauge, open inner door by use of door-switch inside sealer glovebox. Pull out oven rolling shelf, raise elevator by use of lever valve outside glovebox, push module-magazine gently over onto elevator, push shelf back into oven (releasing latch under shelf), close oven door by use of door-switch inside glovebox, and drop elevator slowly by cautious use of lever valve outside glovebox.

Seam Sealing:
Set a module into the recess in the welder work-table or carriage, align lid carefully by hand, position spring-loaded lid-clamp on

top of lid, and push the "weld" switch on the welder chassis inside glovebox. After welder completes its cycle, move lid-clamp aside, then remove module from welder work-table and place it on the Lazy Susan. Repeat with another module, rotating the Lazy Susan to make room as more packages are sealed.

Gross Leak Testing:

Remove a module from the Lazy Susan; place it (using the vacuum parts-handler) in the cavity of the gross leak tester. With both hands, simultaneously press the pushbutton switches on the left and right sides of the tester control box, thereby bringing the tester cylinder and piston down. If the red light goes out and remains out during the approximately 10 seconds while the cylinder and piston are down, the module passes; otherwise it fails. Remove the module (using the parts-handler) and place it on a stacking tray. Parts that fail may be returned to the seam-welder for rework, via the other side of the Lazy Susan.

Nitrogen Wash:

Unlock toggle, and crank open the door between sealer-glovebox and transfer-lock. Place stacked trays of gross-leak-tested modules inside transfer-lock, then crank door shut and lock the door-toggle. Open vacuum valve on transfer-lock panel; after vacuum reaches 7" Hg, close valve; open nitrogen flowmeter valve until vacuum gauge indicates atmospheric pressure; close nitrogen valve; repeat this sequence 3 more times. Then open "N_2 pressure-equalization" flowmeter valve; when flow ceases, unlock door toggle and crank open the door between transfer-lock and fine-leak-tester glovebox. Move stacked trays of modules from the transfer-lock into the glovebox.

Fine Leak Testing:

Load one module into each of the 28 test-chambers, using the vacuum parts-handler. By use of the left-hand lever-valve under glovebox, move test-chamber cover-assembly over the chambers, then by use of the right-hand lever-valve, lower the cover-assembly, such that each chamber is closed under spring pressure. Close V1 and open V2 of Varian leak detector. Turn on power switch on sequencer panel, thereby causing each chamber valve to be opened, in turn, for several seconds. Then open V1, and turn

sequencer power switch off and then back on, and allow the sequencer to sample all the test-chambers (by automatically opening and closing serially the solenoid valves). Any module with a leak rate greater than the threshold set for the system (about 10^{-7} cc/sec typically) will cause a red light to come on, on the left side of the sequencer panel, showing the chamber number containing the faulty module. When the sequencer stops, close V1 and V2 and open the vent valve, on the Varian unit. Turn sequencer power switch off and on , and thus allow sequencer to vent each test-chamber, in turn. By use of the right-hand and then the left-hand lever-valves under the glovebox, raise the cover-assembly and move it away from the test-chambers. Remove the modules from the chambers (identifying any failed modules) and place on stacking trays. Release toggle and open inner door of outlet-lock, move trays into lock, and close inner door. Open outer door of outlet-lock, remove trays of modules, and close outer door.

Every 4 hours, or at intervals determined by experience with the system, remove leak-tester outlet tube from the Varian leak detector, and verify or re-tune the calibration of the latter by use of the standard leak, referring to the Varian detector instruction manual. Occasionally, re-lubricate the test-chamber O-ring seals with a vacuum grease non-retentive of helium, e.g. Apiezon.

3. PERFORMANCE DEMONSTRATION OF MICOM PACKAGE SEALING SYSTEM

3.1 System Check-out

All portions of the system were checked out and found to be operable, except for a failed comparator in the fine-leak-test sequencer. A small number of packages were processed through the system, and all portions of it qualitatively performed their intended functions. The fine-leak tester suffered from a high helium background reading but was able to detect a leaking package.

3.2 Yield Study

3.2.1 Package Feed-through Seal-beads

A sample consisting of 135 of the packages procured for evaluation and demonstration of the sealing system was tested for feed-through glass bead leaks. These packages were tested one by one with the Veeco helium leak detector. Of the 135 packages tested, none were found with leakage greater than the leak-detector sensitivity which was approximately 10^{-8}cc/sec of helium.

3.2.2 Sealing System

Due to a number of factors which appeared more obvious in retrospect than in foresight, the intended yield analysis could not be performed within the time and money constraints of the present contract. A scheduling oversight which could not be rectified before expiration of the available work-time made it necessary to perform the sealing in an air-and-helium atmosphere without the use of dry nitrogen; this caused severe problems with welder electrode oxidation. The SSEC seam-sealers were designed for use with gold-plated Kovar packages, with the gold assuring the absence of a surface oxide layer and furnishing a filler braze material to bridge any gap between adjacent weld-nuggets or fusion areas. The nickel-plated packages used in this study required much greater welding heat to form strong bonds, and much greater plastic deformation of the weld to roll-under the surface oxides, even with local helium-blanketing of the weld areas. Consistently-adequate weld penetration was not obtained even at maximum welder power (the possibility that some of the output power transistors in the seam-sealer power supplies were not functioning, was not explored, though there was some reason to suspect this). Furthermore, the weld electrode bearings did not roll as freely as they should, a fairly serious problem for this type of welder. The above-mentioned factors need to be dealt with before the yield capabilities of the system can be analyzed. An experimental run of 10 packages was sealed and leak-tested; 8 of them passed the gross leak test and 2 of them marginally passed the fine leak test; however, the importance of the above-mentioned adverse factors would make it unrealistic

to draw any conclusions from this run. For any package seam-welding operation, yield is determined largely by package characteristics, package and electrode cleanliness, welder mechanical and electrical set-up, and operator know-how; the MICOM sealing system does not possess any unique characteristics in this regard. Therefore, given compatible packages and proper machine set-up parameters, yield should be comparable with that of any SSEC seam-sealer.

3.3 Throughput Rate Analysis

3.3.1 Package Feed-through Leak Tester

This machine still had leakage too great to allow operation with the helium mass spectrometer, but throughput rate could be estimated with fair confidence by mechanical operation of the system. The following times were obtained for a run of 30 packages (one full machine load):

Step	Time, minutes
1. Load packages into machine	2
2. Operate valves, evacuate, back-fill	3
3. Fine leak test (all pkgs. in parallel)	3
4. Unload packages	2
	10 total

This corresponds to a throughput rate of 180 packages per hour, assuming all packages pass the test. If individual testing of each package were required, test time would increase to about 30 minutes, reducing throughput rate to 60 packages per hour. If one may consider the test results reported in Paragraph 3.2.1 to be typical, in most cases sequential one-by-one testing would not be required, and average tester throughput rate would exceed 100 packages per hour.

3.3.2 Sealing and Leak-testing System

A run of 100 packages was processed through the system, with

times being measured for each of 6 major divisions of the process. Times were as follows:

Step	Measured Time, minutes	Theoretical* Time, minutes
1. Load packages/lids into magazine	32	16
2. Vacuum bake	12+bake time	**
3. Seam-weld, load Lazy Susan	60	30
4. Gross leak test, load trays	38	19
5. Transfer, nitrogen wash	8	4
6. Load/unload chambers, fine leak test	59	59

* Assuming both sides of system were used.

** Assuming a 24 hour bake and a full oven load of 6 magazines holding 416 packages each, that is 2496 modules per 24 hour bake plus 72 minutes loading time, or 99 modules per hour.

Since 3-shift operation seems unlikely, and 24 hour bake seems excessive, Step 2 would probably not be the limiting item. Assuming the system is fully supplied with operators (one loader/unloader/transferrer, two welders, two gross-leak testers, one fine-leak tester), including relief workers, the limiting bottleneck is the fine leak tester, which would set the system throughput rate at 100 modules per hour or 800 modules per 8-hour shift. Operator learning curves, monotony factors, use of less than a full complement of operators, work scheduling problems, etc., which would be strong factors in an actual manufacturing situation, were not considered in this analysis.

4. SUMMARY

Approximately 1000 microcircuit packages and lids were procured, the MICOM High-Throughput Package-Sealing and Leak-Testing System was brought into operation, a sufficient number of packages were sealed and leak-tested to determine approximate operating parameters of the System, and System documentation was prepared.

4.1 Conclusions; Critique of System

By the expenditure of about 4 man-months of engineering effort in making minor modifications and repairs to the System, the latter could be made capable of performing its intended function (assuming use of gold-plated packages) in a fully satisfactory manner, with yield probably in excess of 95% and throughput rate of approximately 100 modules per hour. No major errors in system nor subsystem design were found, though a number of moderate problems were encountered.

4.2 Recommendations

4.2.1 It should be decided whether the MICOM Sealing System is to be used (a) only for gold-plated packages or (b) also for nickel-plated packages. If (a), then about 200 gold-plated packages should be procured, and the seam-sealers should be inspected, refurbished, set up, and tested, with those packages. If (b), then it seems likely that different seam-sealer power supplies will be required, and possibly other substantial changes will be needed in the seam-sealers. The writer has had good package seam-welding experience in using a much simpler power supply consisting of a step-down transformer with a variable resistor in the primary, directly connected to the 115 VAC 60 Hz supply line; he does not share the SSEC philosophy of welder power supply design.

4.2.2 The vacuum-bake magazine shelves should be spaced slightly farther apart, for adequate clearance when rotated in a loaded condition, and should be pivoted with friction drag on the central shaft, not on the shelf above and the shelf below as at present. Furthermore, it may be desirable to replace the locating studs with a grid of oversize holes on 0.1 inch centers, which would allow the magazine to be used for several standard package sizes and shapes, thus increasing flexibility of use.

4.2.3 The flowmeters and valves which back-fill the vacuum ovens with nitrogen/helium mixture should be increased in size, to

provide reasonable back-fill times. It may be preferable to connect the back-fill "vent" valves to the sealing glovebox rather than to the nitrogen/helium supply line as at present.

4.2.4 The elevator platform for handling the magazine has a vertical "step" around its edge, which makes its use difficult; this should be removed.

4.2.5 The glovebox Photohelic controllers should be changed to cut off the fast-fill flow as soon as the glovebox pressure returns to normal, instead of fast-purging until an over-pressure is obtained.

4.2.6 The compressed-air aspirators for the vacuum parts-handlers should be replaced by a mechanical pump or house vacuum, to eliminate excessive irritating noise.

4.2.7 There is evidence of excessive leakage in the sealer glovebox; perhaps due to some of the window seals, which need to be refurbished.

4.2.8 The inter-glovebox transfer-lock door cables should be replaced by stronger cables; one of them broke during operation.

4.2.9 The electrode shaft material on the SSEC seam-sealer should be changed to copper and/or fins should be added, to avoid overheating the bearings and mercury slip-rings during high-throughput-rate operation.

4.2.10 The weld-control Microswitch on the SSEC welder arm should be replaced by a zero-hysteresis contact (the 4 mA, 20 VDC sensing current does not require a snap-action switch), or else the weld power turn-on and turn-off should be controlled by a sensor that directly detects the passage of the leading edge and trailing edge of the package under the electrode shaft centerline. This probably is preferable to using the resistance-sensing weld power control of the SSEC seam-sealer, which tends to give the misleading impression of guarding against package corner arcing while not

necessarily doing so.

4.2.11 It would seem desirable if welder electrode force and corresponding weld current could be increased considerably beyond the values standard for the SSEC seam-sealers, to provide greater plastic deformation of the weld fusion zone and thereby reduce sensitivity to non-planarity of and contamination of the weld faying surfaces.

4.2.12 The gross leak tester electronics should be improved in stability and the comparator switching threshold should be sharpened; at present, the turn-on/turn-off points of the go/no-go indicator lights overlap, with no provision for adjusting out this overlap, and the light turn-on thresholds are too gradual to allow setting for high leak-detection sensitivity.

4.2.13 Provision should be made for opening all test-chamber solenoid valves of the fine leak tester simultaneously, to hasten pump-down and venting, and to allow simultaneous leak-testing of 28 modules at one time, when yields are at a high level.

4.2.14 The fine-leak-tester sequencer failure-indicator level-detector needs to be repaired; its comparator appears to have failed. The failure-indicator level-setting potentiometer should be mounted on the front panel of the sequencer box rather than inside, to allow easy selection of the go/no-go leakage level for differing package sizes.

4.2.15 The Package Feed-through Leak Tester could be made satisfactory by immersing its valves and manifold in a tank of oil; its plumbing is too dense to allow detection and correction of the existing small leaks in the plumbing underneath the manifold. It would seem desirable if larger-cross-section shorter-length connection could be made between the manifold and the Veeco leak detector, to improve response time.

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